326910 GR. 2

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DOCUMENT CONTROL ADMINISTRATOR

326910 G2 S2

INSTRUCTION BOOK

Model 56A
DC NULL DETECTOR
Serial # 567 and above

SER # 410
Power Supply

1-68

BOONTON ELECTRONICS CORPORATION
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SECTION I

MODEL 56A

SPECIFICATIONS

Voltage Range:	1.0 μV to 100 V dc.
Current Range:	10^{-13} to 10^{-5} dc.
Input Capacitance:*	22 pF .01 to 100 range without cable 46 pF 1K to 100 K range without cable 150 pF .01 to 100 range with cable 175 pF 1K to 100K range with cable
Input Resistance:	10 megΩ all ranges
Sensitivity Ranges:	8, calibrated in amplifier gain 0.01, 0.1, 1.0, 10, 100, 1K, 10K, 100K
End Scale Sensitivities:	(SENS. ADJ. at max.)
Voltage:	10 μV to 100 V dc.
Current:	1 pA to 10 μA
Power:	10^{-17} W to 10^{-3} W
Sensitivity per Division on Most Sensitive (100K) Range:	
Voltage:	0.5 μV
Current:	0.05 pA
Noise Level:	Less than 1 μV P-P
Zero Drift:	Less than 2 μV after warm-up
Response Time:	Approximately 1 second end-scale.
Modes of Operation:	
Hunt:	Provides 60 dB meter scale compression
Calibrate:	Provides linear indication with resolution to 0.5 microvolt.

* Input capacitance measured with 100 Kc/s test frequency.

SPECIFICATIONS (cont'd)

Mode Switching:	Front panel or by remote switch.
Meter:	1.2 - 0 - 1.2 scale.
Meter Linearity:	2% maximum error.
Amplifier Gain:	Continuously variable from -60 dB to +100 dB.

Output Characteristics

Output:	Continuously adjustable from 0 to ±1.0 V into 1000 Ω; polarity same as input. One terminal at chassis potential.
Impedance:	Approximately 2000 Ω
Ripple:	Less than 0.01V RMS

Overload Tolerance:

Range	Approximate End Scale Voltage	Overload Voltage Tolerated
0.01	100V	1000V
0.1	10V	1000V
1	1V	1000V
10	0.1V	1000V
100	0.01V	100V
1K	1 mV	10V
10K	0.1 mV	10V
100K	0.01mV	10V

Power Requirements: 105 to 125V, 50-60 cycles, 40 watts; or 210 to 250 volt, 50-60 cycles (Special)

Size: Portable 7-1/4 W x 10-1/2 D x 11 H excluding handle.

Rack 19 W x 10-1/4 D x 7 H with handles

Weight: 12 lb. net.

SECTION II

GENERAL DESCRIPTION

The Model 56A DC Null Detector is a sensitive, high impedance Electronic Amplifier/Indicator, designed for use with dc bridges or for other applications where sensitivities are required that are considerably greater than those available from the best mechanical galvanometers.

The 8 step "Sensitivity" switch allows inputs decading from 10 microvolts to 100 volts to give end scale deflection on the zero center meter. The meter is calibrated on each side of zero in divisions of .05 for a "end scale" of 1.0 with an over-calibration of 20%. A sensitivity control used in conjunction with the range switch permits relating a desired percentage tolerance to the limits marked in red at 1.0 on the meter scale. A switch allows the selection of either a compressed or linear amplifier mode of operation. In the compressed (HUNT) mode of operation, 60 dB of meter scale compression virtually eliminates the need to switch ranges when hunting for a balance with an unknown component. In the linear (CAL) mode the meter scale is linear over a -1.2 to $\pm$ 1.2 range. The HUNT-CAL switch may be operated at the front panel or remotely by cable connection to a side receptacle.

The input circuit may be operated either grounded or floating. The instrument case and panel are connected through the power line cable to ground. Terminal 1 of the input receptacle is connected to the amplifier chassis which is insulated from the instrument case by approximately 500 megohms. The instrument will withstand a DC Potential of 1000 volts between case and ground. The amplifier chassis may be grounded by connecting the shorting link between the Ground and Floating Chassis terminal posts located on the front panel.

The Model 56AR DC Null Detector is electrically identical to the Model 56A. Physically, the components have been rearranged to mount on a 7" x 19" standard rack panel, and the Output Level Control (R26) has been moved to the front panel for accessibility.

TABLE 1-1 Equipment Supplied:

No. per Equipment	Name of Unit	Overall Dimensions H	W	D
1	Model 56A DC Null Detector	12-1/4	7-1/8	9-3/8
1	Input Cable Assembly	4 ft. approximately		
1	Plug (Jones P-302-CCT) for HUNT/CAL switch receptacle.			

1 Instruction Book.

TABLE 1-2 Electron Tube Complement:

No. per Equipment	Tube Designation	Type	Function
1	V5	6X4	Rectifier
1	V6	OA2	Voltage Regulator
1	V1	12AX7	Amplifier
1	V2	6AU7	Amplifier
2	V3, V4	12AT7	Amplifiers

TABLE 1-3 Fuse Complement:

Fuse Rating. MDL 1/2 Ampere (117 V operation)

TABLE 1-4 Chopper Complement:

1 Mechanical Chopper	BEC 540,108
2 Transistor Choppers	2N1302

SECTION III

OPERATING PROCEDURE

3.1 General

This section outlines operating procedures for the Model 56A Null Detector. The operator should familiarize himself with this material before using the instrument.

3.2 Initial Inspection and Installation

3.2.1 Observe the meter pointer to see that it moves freely and rests at zero when the instrument is steady. If the pointer rests either to the right or left of zero, set it with the Mechanical zero set screw.

3.3 Turn-On Procedure

3.3.1 Verify that the power source and power rating plate agree, or use a suitable converter.

3.3.2 Connect input cable assembly to the instrument at jack marked INPUT.

3.3.3 Allow a warm-up period of approximately 10 minutes.

3.3.4 Set the SENSITIVITY selector switch (S1) on 100K, the SENS. ADJ. (R35) at Max., and HUNT-CAL switch (S2) on CAL. Short the input by connecting the red and black clips. Zero the meter using the ZERO control (R45).

3.3.5 In an instrument capable of indicating an input signal as small as a fraction of a microvolt, several sources of unwanted meter indications are of importance. Two of the most common of these are hum pickup and thermal voltages.

The 56A includes a 60 ∿ rejection filter which reduces hum pickup effects by more than 60 db. Ideally the 56A and bridge should not be placed in the presence of a strong ac field. If this cannot be avoided the instruments, and in particular the bridge output and 56A input terminals should be carefully shielded.

Thermal voltages are the result of a temperature change at the junction of dissimilar metals. In the input circuit of the 56A, considerable care has been taken through the choice of materials and placement of parts to minimize thermal voltages. Similar care must be taken with the circuit to which the input cable of the 56A is connected. (The insulated alligator clips provided with the 56A are made of beryllium copper. When attached to the phone tip prods of the input cable and shorted to each other the resultant thermal voltage is negligible.)

Other effects that may produce unwanted deflections of the null indicator are:

a. Galvanic action (battery effects)

b. Photosensitivity (particularly with semiconductor devices)

c. Amplifier noise usually caused by noisy tubes, resistors, or capacitors in the input stage.

3.4 Procedure for use with a Wheatstone Bridge

3.4.1 Connect the 56A input leads to the bridge output, observing proper polarity.(black to ground or shielded bridge terminal). Disconnect the internal galvanometer in the bridge. In some instances it will be desirable to unscrew the insulated alligator clips in order to use the phone tips as connecting devices.

3.4.2 Connect the unknown resistance to the bridge and select an appropriate setting of the bridge ratio arms.

3.4.3 Check the null indicator for correct zero adjustment as in paragraph 3.3.4. Then set the SENSITIVITY switch to .01 range.

3.4.4 Apply the dc voltage (See Overload Tolerance in Specifications) to the bridge. It is conventional to use a battery polarity which will give null indicator deflection to the right (positive) when the resistor under test is higher in value than the bridge setting. Proceed with the normal bridge balancing procedure adjusting the decade resistors until the null indicator of the 56A reads zero. If no deflection of the null indicator occurs, turn the SENSITIVITY switch clockwise until a deflection is achieved.

3.4.5 If the null indicator deflects a negligible amount with a one-step change in the setting of the lowest resistance decade of the bridge, the sensitivity of the 56A should be increased. Increase the setting of the SENSITIVITY switch until a position is found that will give satisfactory null indicator deflection. Observe the null indicator pointer for several moments to assure that thermal voltages (as evidenced by a slow drift in one direction) are not present. On the 100K SENSITIVITY position a moderately fast motion (jitter) of about 1/2 division is normal.

Avoid the use of excessive sensitivity. Difficulty in locating a balance can be the result of using too much sensitivity.

3.5 Procedure for use with a Limits or Unbalanced Wheatstone Bridge.

3.5.1 Resistors can be selected to tolerances or matched very rapidly using the following method:

a. Connect the 56A to the bridge as in 3.4.1.

b. Connect to the measuring posts of the bridge a nominal resistor from which percentage deviations are to be measured.

c. Balance the bridge as in 3.4.3 through 3.4.5 with the HUNT-CAL switch in CAL position.

d. Unbalance the bridge by that percentage of the nominal resistance (as measured) which is to be used as a limit for production test. This unbalance can be achieved either by adding appropriate series or shunt resistors to the standard resistor, or, most conveniently by adjusting the resistance decades of the bridge by an amount which is equal to the desired resistance limit.

e. Adjust the null indicator pointer of the 56A to the limit line (1.0) using the SENS. ADJ. control. Reset the bridge to the specified nominal resistance value. The null indicator scale of the 56A may now be used to observe a range of plus or minus the desired percentage tolerance with a 20% extended calibration at each end of the scale.

When the standard resistor is replaced with production resistors to be tested, the 56A will evaluate the test resistor as a decimal part of the tolerance without the necessity for any further bridge or equipment adjustments.

Example: a batch of resistors is to be selected to 11,085 Ω ± 0.5%.

Select a resistor at random and measure its resistance on the bridge. See paragraph 3.4. Assume this measured resistor were 11128 ohms. Change the bridge setting to equal value of the measured resistor plus the tolerance:

11128 Ω + 55.64 Ω = 11183.64 Ω (Round off to 11184)

If conventional bridge battery polarization has been used, the null indicator has deflected to the left. With the SENS. ADJ. control adjust the null indicator to read -1.0. Do not disturb the SENS. ADJ. control after this adjustment.

Return the bridge setting to the nominal resistance value. Remove the random selected resistor from the bridge test posts. The bridge and 56A Null Detector are now set-up for fast production testing of resistors.

When a resistor is connected to the bridge test posts, the indicator of the 56A will show the direction in which it differs from the nominal and the amount in a decimal part of the tolerance. A null indicator reading of +.3 is interpreted:

.3 x .5% = .15%
11085 x (.15%) = 16.6 Ω above nominal
or 11085 + 16.6 = 11101.6 Ω.

3.6 Procedure for using HUNT mode of operation

3.6.1 This mode is advantageous when "hunting" for the value of a resistor whose order of magnitude is unknown, or when adjusting an "over-wound" resistor to a very close tolerance. The procedure is as follows:

a. Connect the 56A and unknown resistor to the bridge as in 3.4.1.

b. With the HUNT-CAL switch in the HUNT position, apply the dc to the bridge and observe the deflection of the indicator.

c. Adjust the bridge resistance decade in a direction to move the null indicator pointer toward zero. Note that for conditions of large unbalance, a large change in the resistance decade setting produces a relatively small movement of the pointer and that as balance is approached the null indicator becomes progressively more sensitive to changes in the resistance decade arm of the bridge.

d. For greatest accuracy of null detection the 56A should be returned to the CAL mode of operation after the bridge has been brought close to balance in the HUNT mode.

The bridge and 56A may be set up for limits operation, then switched to HUNT mode for rough adjustment or "hunting", and returned to the CAL mode for final precise measurement or adjustment.

A receptacle (J4) at the right side of the 56A permits use of an external switch. This receptacle is wired in parallel with the HUNT/CAL switch (S2). When the panel HUNT/CAL switch is in the CAL position, closing the receptacle circuit, (as with an external foot switch) places the 56A in the HUNT mode of operation. In some cases a foot switch selection of the HUNT/CAL is desirable because it frees both hands of the operator for making adjustments on the resistor under test.

3.7 Amplifier Output

3.7.1 The ± 1 volt dc output of the Model 56A is available at terminal posts on the front panel. This voltage is referenced to chassis potential and may be used to operate a dc recorder, voltage comparator or other external equipment. The amplifier gain is continuously adjustable from 0 to 100 dB by means of the range switch and the output level control (located on the left side of the instrument). The amplifier output may be used simultaneously with the indicating meter without interaciton.

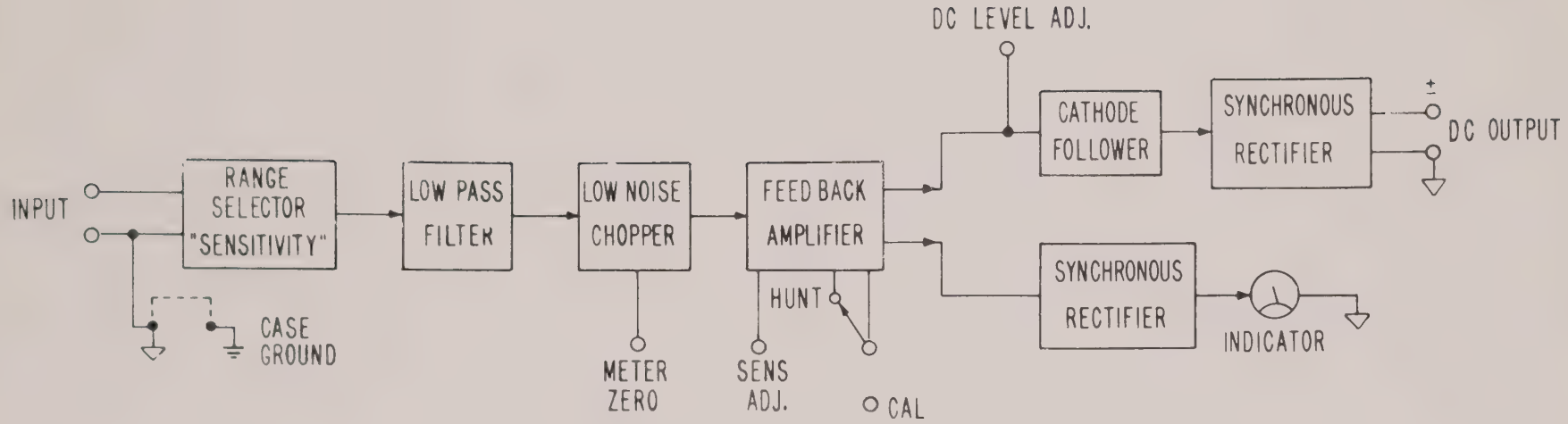


FIGURE 1. BLOCK DIAGRAM
MODEL 56A

SECTION IV

THEORY OF OPERATION

4.1 General

A simplified block diagram is shown in Figure 1. The circuit consists of an input range switch; a filter to reduce the effect of the external hum pick-up, a chopper which converts the dc to ac of the power line frequency; a four stage negative feedback amplifier; a transistorized synchronous rectifier that restores the amplified ac to dc; a zero-center dc microammeter indicator; a cathode follower output amplifier, a synchronous rectifier, and a power supply.

4.2 Range Switch

The input dc voltage is applied to an 8 position selector switch, which, on the three most sensitive ranges controls the feedback in the amplifier. On the five lower ranges of sensitivity the input voltage is divided to 1 millivolt and applied to the low pass filter. The input circuit has the "ground" conductor carried on the connector contacts to minimize ground loops and series resistance problems which can occur when ground is carried by the connector shell. The shielded input cable is terminated in insulated phone tips with detachable insulated alligator clips. The input system is arranged so that the input resistance remains essentially constant at 10 megohms on all ranges.

4.3 Low Pass Filter

The range switch output is applied to a multisection low pass filter which attenuates unwanted 60-cycle pick-up by at least 60 db. Frequencies above a few cycles are also attenuated by the filter. This restricts the use of the 56A to dc or very low frequency ac applications. Because the amplifier is designed for amplifying the low level 60-cycle output of the chopper, the rejection of unwanted 60-cycle voltages at the input is imperative.

4.4 Converter Chopper

The dc at the filter output is applied to a low-noise mechanical chopper which converts it to an alternating voltage of the same frequency as the ac power source. A bias voltage applied to one side of the chopper serves as the meter zero adjustment.

4.5 Amplifier

The chopper output is capacitively coupled to a two stage, low-noise, non-microphonic dual-triode amplifier. The third stage is a high-gain pentode which couples into a medium gain amplifier stage consisting of half of a dual-triode. The remaining half of the dual-triode operates as a cathode follower with

the SENS. ADJ. control in its grid circuit. Amplifier stages are R/C coupled. These coupling networks and associated filters have been designed for 50 to 60 cycle operation with pronounced roll-off in gain outside this band. A portion of the output is applied out-of-phase to the first and third stages. The amount of this negative feed-back is selected by the range switch to give the required over-all gain on each of the three most sensitive ranges.

4.6 Synchronous Rectifier

The output of the cathode follower is applied to a transistor rectifier. The driving voltage for the transistor is so phased that the polarity of the rectified voltage is the same as the polarity of the voltage at the input to the DC Null Detector. The polarity and amplitude of the rectifier output are indicated on the 6-inch zero-center meter.

4.7 Power Supply

The power supply circuits provide: regulated 150 volts for the plates of the tubes in the first four stages of the amplifier; +190 volts unregulated for the fifth amplifier stage and the cathode followers; and low voltage dc for the filaments of the first three stages of the amplifier. The remaining filaments are operated from 6.3 volt ac from the power transformer. A -14 volt bias voltage is also supplied for meter zeroing.

4.8 Cathode Follower

The ac voltage from the plate of the output amplifier is applied to the output level control which varies the input to the grid of one triode of the cathode follower. A synchronous rectifier converts the cathode follower output from ac to dc. Output filtering is accomplished by a smoothing filter in the output circuit. The amplitude of the dc output is directly proportional to that of the input with the instrument operated on the CAL position. In both modes the polarity of the output is the same as that of the input.

SECTION V

CALIBRATION & OPERATIONAL CHECKOUT PROCEDURE

5.1 Equipment needed:

a. Megohmmeter: Freed type 1020B or equivalent

b. Variable Transformer: Superior Electric Powerstat

c. Type 2PF10 (1A) or equivalent.

d. Resistance Bridge: Electro-Measurements Model 230R

e. DC Null Detector: Boonton Electronics Model 56A

f. VOM: Triplett Model 630A or equivalent

g. Ballantine AC Voltmeter Model 314 or equivalent

h. Recorder: Rustrak Model A or equivalent

i. Resistor: 2200 Ω, 1/2W, 5%

j. Resistor: 1000 Ω, 1/2W, 5%
DC Voltage sourve variable from 10 μV to 100V, ± 0.5%

5.2 Non-operating inspection

Meter zero adjustment. If the pointer is off zero, rotage the screw located in the center of meter case CCW or CW until the pointer rests at zero. Remove the shorting link between ground and floating chassis posts and connect the megohmmeter across the posts. The measured resistance should be above 500 megohms.

5.3 Amplifier Calibration

5.3.1 Set the AC operating voltage to 115 VAC and allow instrument to warm up for at least 15 minutes. Connect the chassis grounding link. Be sure to use the adapter plug attached to the end of the line cord with the ground wire disconnected. This will open any major ground loops which may affect the instrument. It should be noted that under normal operating conditions when the standard NEMA plug (three-prong) is used, the grounded binding posts and black input cable clip are at power-system ground potential.

5.3.2 With input cable removed and instrument turned on, set range to 1K. Measure the input impedance across #1 and #2 of input receptacle J2 using the Resistance Bridge and DC Null Detector. If a reading of 10 megohms ± 1/2% is not obtained the following adjustment must be made: Remove the two #8 screws on each side of the cabinet near the front panel.

Remove the two #6 screws on the rear of the cabinet. The front panel and amplifier assembly can now be removed from the front of the cabinet. Remove the #4 screws securing the bottom plate to the amplifier and readjust the trimming capacitor C21 located at the base of the chopper socket XCH-1 with a non-metallic alignment tool. Before proceeding with the test it is recommended that a check be made for + 190 VDC ± 10% between Amplifier Chassis and Pin 1 of V4 and + 150 VDC ± 3% between Amplifier Chassis and Standoff E1 (R27). Replace bottom plate and Amplifier Assembly in cabinet, and secure screws.

5.3.3 Connect input cable to input receptacle and short the black and red clips together. Set range to 10K with SENS. ADJ. at maximum and HUNT/CAL in CAL. position. Set meter ZERO control to vertical position. Adjust R56 (located on top of amplifier chassis) for a meter indication of zero. Vary meter ZERO control (R45) from full CCW to CW. Meter should indicate approximately end-scale on both sides of zero. Set range to 100K and reset to zero. For accurate meter zeroing the input cable should be connected to the same source impedance, and without voltage present.

5.3.4 Set instrument to the 100K range, set zero and apply 10 V of either polarity from a DC Voltage source to the input cable. Adjust #1 control located on lower right side of cabinet for end scale deflection. Reverse polarity of test voltage and readjust #1 control if necessary to average the polarity reversing error if any exists. If an adjustment was necessary, meter zero must be rechecked and calibration repeated.

The voltages necessary to calibrate the instrument are as follows:

100K Range;	10 μV	10 Range:	100 mV
10K Range;	100 μV	1 Range:	1 V
1K Range;	1 mV	0.1 Range:	10 V
100 Range;	10 mV	0.01 Range:	100 V

5.3.5 Repeat 5.3.4 procedure for 10K range, adjust #2 control.

5.3.6 Repeat 5.3.4 procedure for 1K range, adjust #3 control.

5.3.7 Check all ranges from 100 to 0.01 for full scale accuracy ± 3%. If the instrument is out of calibration on any range above 1K, repeat step 5.3.6, averaging out the error until all ranges from 1K to 0.01 are within the end scale accuracy of ± 3%. This completes the calibration of the instrument.

5.4 Instrument and Amplifier Output Test

5.4.1 Set range to 1K and set Zero; apply dc voltage for end scale deflection; record positive and negative indication.

5.4.2 Reduce line voltage to 105 V, ac, and repeat 5.4.1.

5.4.3 Increase line voltage to 125V, ac, and repeat 5.4.1. Change in readings between 5.4.1, 5.4.2, & 5.4.3 should not exceed 2% of 5.4.1. Reset line to 115V.

5.4.4 With range set to 1K and with zero input voltage, connect the 1000 Ω resistor in parallel with the VOM across the output terminals.

5.4.5 Set output level control to maximum and apply +1 mV to the input. Output voltage should be more than +1 V. Reverse input polarity; output should be more than -1V.

5.4.6 Decrease output level to 1V with the output level control. Decrease input voltage by a series of 20% steps to zero and then increase in opposite polarity in level non-linearity (tracking error) should be less than 2% of full scale.

5.4.7 Apply +1 mV input and replace VOM with the AC VTVM. The output ripple should be less than 0.01 V, RMS.

5.4.8 Remove Ballantine meter and adjust SENS. ADJ. control for a meter indication of 0.8. Switch HUNT/CAL control to HUNT and increase input voltage for maximum meter indication. The input voltage should now be 30 mv or more.

5.5 Amplifier Drift and Noise Test

Before drift and noise checks can be made, the instrument must have been off for at least an hour. Also, these checks must be made with the shorting link in the grounded position. The input cable must be replaced with a U shaped shorting bus between pins 1 and 2 of the input connector, J1. The SENS ADJ control is set at maximum and the HUNT/CAL selector in the CAL position. The dc output is connected to a recorder which is adjusted for 1 V full scale sensitivity. The instrument is then turned on (from a cold start). With the instrument set to 100K, the meter is zeroed, and the recorder started. The distance between the recorder and the Model 56A should exceed 2 feet, since the strong ac field from the recorder may cause indications which will affect the calibration and check-out of the instrument.

After a 3-hour recording is completed, the recorded drift should be less than $\pm$ 2 μV after the first hour. The noise (width of the recorded output) measured any time after the first half-hour should not exceed 1 μV, peak-to-peak.

TABLE OF REPLACEABLE PARTS

REFERENCE			DESCRIPTION			BEC PART NO.
C1	Capacitor		0.022 µF	200V		230101
C2a	"	Elec.	20 µF	475V		283109
C2b	"	Elec.	50 µF	50V		P/O 283109
C2c	"	Elec.	20 µF	25V		P/O 283109
C3	"	Elec.	50 µF	6V		283112
C4	"		0.005 µF	200V		230121
C5	"		0.022 µF	200V		230121
C6	"	Elec.	5 µF	6V		283108
C7	"		0.005 µF	200V		230121
C8	"		0.005 µF	200V		230121
C9	"		0.1 µF	200V		230116
C10	"		0.1 µF	200V		230116
C11	"		0.1 µF	200V		230116
C12	"		1.0 µF	200V		230104
C13	"	Elec.	50 µF	6V		283112
C14	"	Elec.	5 µF	150V		283173
C15	"	Elec.	20 µF	100V		283178
C16	"	Elec.	25 µF	25V		283172
C17	"	Elec.	25 µF	25V		283172
C18	"		0.1 µF	200V		230116
C19	"		0.05 µF	200V	10%	230117
C25	"		0.022 µF	200V		230101
C26	"		0.022µF	200V		230101
C27	"		0.1 µF	200V		230116
C28	"		0.1 µF	200V		230116
C29	"	Mica	300 pF	500V	5%	201128
C30	"	Trimmer	37-250 pF			275118
C31	"		0.33 µF	200V		234032
C32a	"	Elec.	20 µF	450V		283113

REFERENCE			DESCRIPTION			BEC PART NO.
C32b	Capacitor	Elec.	20 µF	450V		P/O 283113
C32c	"	Elec	20 µF	450V		283113
C33	"	Elec.	5 µF	50V		283143
C34a	"	Elec.	1000 µF	15V		283114
C34b	"	Elec.	1000 µF	15V		P/O 283114
C35	"		0.05	100V		224117
C36	"		0.05	100V		224117
C37	"		0.05	100V		224117
R1	Resistor		6.8 Meg	1/2W	5%	301179
R2	"		1 Meg	1/2W	1%*	306598
R3	"		1 Meg	1/2W	5%	301159
R4	"		1K	1/2W	5%	301087
R5	"		47K	1/2W	5%	301127
R6	"		2.2 Meg	1/2W	5%	301167
R7	"		1 Meg	1/2W	5%	301159
R8	"		10K	1/2W	5%	301111
R9	"		47K	1/2W	5%	301127
R10	"		2.2 Meg	1/2W	5%	301167
R11	"		470K	1/2W	5%	301151
R12	"		1 Meg	1/2W	5%	301159
R13	"		2.2 Meg	1/2W	5%	301167
R14	"		100K	1/2W	5%	301135
R15	"		2.2K	1/2W	5%	301095
R16	"		1 Meg	1/2W	5%	301159
R17	"		470Ω	1/2W	5%	301079
R18	"		18K	1/2W	5%	301117
R19	"		10 Meg	1/2W	10%	306635
R20	"		10 Meg	1/2W	10%	306635

REFERENCE		DESCRIPTION				BEC PART NO.
R23	Resistor		10K	1/2W	5%	301111
R24	"		18K	1/2W	5%	301117
R25	"	Var.	1 Meg	2W	20% (Sens.)	311133
R26	"	Var.	1 Meg			311133
R28	"		470Ω	1/2W	5%	301079
R29	"		1K	1/2W	5%	301087
R31	"		470Ω	1/2W	5%	301079
R35	"		470K	1/2W	5%	301151
R36	"		100K	1/2W	5%	301135
R37	"		18Ω	1/2W	5%	301145
R38	"		330K	1/2W	5%	301147
R39	"		220K	1/2W	5%	301143
R40	"		8.92 Meg	2W	0.5%*	323501
R41	"		220K	1/2W	5%	301143
R42	"		100K	1/2W	5%	301135
R43	"		150K	1/2W	5%	301139
R44	"		2.2K	1/2W	5%	301095
R45	"		1 Meg	1/2W	1%*	306598
R46	"	Var.	1K			311100
R47	"		3.9K	1/2W	5%	301101
R48	"	Var.	2K			311114
R49	"		47K	1/2W	5%	301127
R50	"	Var.	25K			311115
R54	"		33K	1/2W	5%	301123
R55	"		68K	1/2W	5%	301131
R56	"		9 Meg	1W	1%*	307686
R57	"		1 Meg	1/2W	1%*	306598
R58	"		90.9K	1/2W	1%*	306474
R59	"		9.09K	1/2W	1%*	306354
R60	"		909Ω	1/2W	1%*	306234

REFERENCE			DESCRIPTION			BEC PART NO.
R61	Resistor		100Ω	1/2W	1%*	306120
R86	"	Var.	50K	2W	20% (Zero)	311125
R87	"		100K	1/2W	5%	301135
R88	"		15K	1/2W	5%	301115
R89	"		1K	1/2W	5%	301087
R90	"		1K	1/2W	5%	301087
R91	"		20K	5.25W	5%	310145
R92	"		1 Meg	1W	20%	302128
R93	"		4.7K	1W	5%**	302117
R94	"		7.5K	10W	10% WW	312100
R95	"		3.9K	2W	5%	304101
R97	"		1.2K	1/2W	5%	301089
R98	"	Var.	250K	1/10W	20%	311122
R102	"	Met. F.	3.9K	1/2W	5%	315002
R103	"	Met. F.	3.9K	1/2W	5%	315002
R104	"		330K	1/2W	5%	301147

* Precision Resistors
** Factory Selected

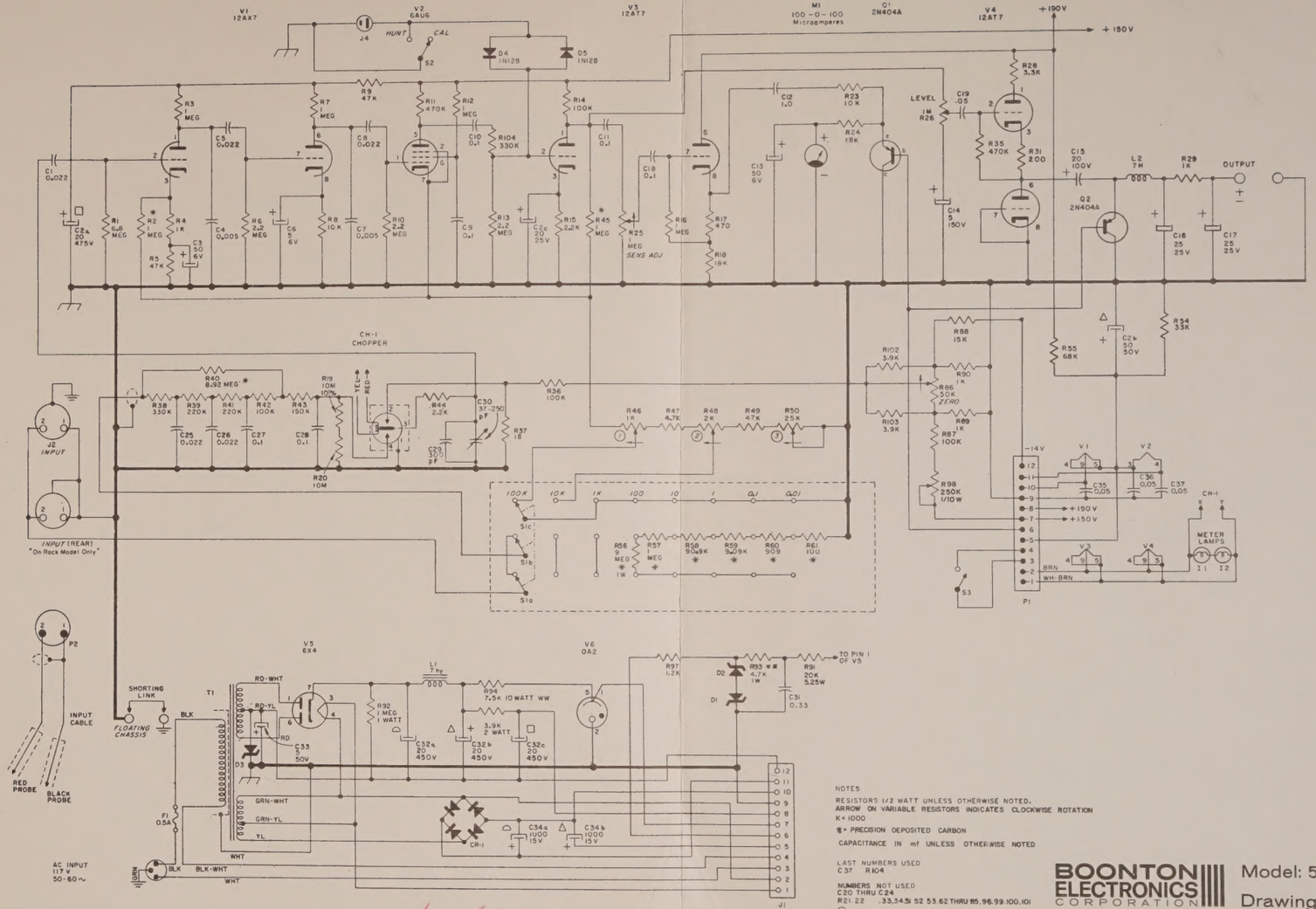
(See following pages for additional parts)

ADDITIONS TO 56A PARTS LIST

REFERENCE		DESCRIPTION	BEC PART NO.
CH1	Chopper	Special	540108
CR1	Rectifier	Sarkes-Tarzian #304B	532001
D1	Diode Zener	1N1775	530026
D2	Diode Zener	1N1775	530026
D3	Diode Zener	1N1775-A	530046
D4	Diode	1N128	530007
D5	Diode	1N128	530007
D6	Diode	1N251	530043
F1	Fuse	Buss 1/2 MDL	545504
I1	Lamp	GE 323 3V	545106
I2	Lamp	GE 323 3V	545106
L1	Choke	7 H Stancor #C1707	440001
L2	Choke	7 H Stancor #C1707	440001
M1	Meter	100-0-100 μA Special	554138
Q1	Transistor	2N1302	528016
Q2	Transistor	2N1302	528016
S1	Switch	3 pole 12 pos. CRL #PA2008	466123
S2	Switch	SPDT CRL #1460	466124
S3	Switch	SPST CRL #110-63	465105
T1	Transformer	Power Special	446007
V1	Electron Tube	12AX7 Special	525001
V2	Electron Tube	6AU6	526,6AU6

Additions to 56A Parts List

REFERENCE		DESCRIPTION	BEC PART NO.
V3	Electron Tube	12AT7	526,12AT7
V4	Electron Tube	12AT7 Special	525002
V5	Electron Tube	6X4	526,6X4
V6	Electron Tube	OA2	526,OA2



this power supply in Ser #410

NOTES

RESISTORS 1/2 WATT UNLESS OTHERWISE NOTED.
ARROW ON VARIABLE RESISTORS INDICATES CLOCKWISE ROTATION
K = 1000

* = PRECISION DEPOSITED CARBON

CAPACITANCE IN mf UNLESS OTHERWISE NOTED

LAST NUMBERS USED
C 37 R 104

NUMBERS NOT USED
C20 THRU C24
R21.22 .33.34.51 52 53.62 THRU 85.96.99.100.101

(f) - CALIBRATION CONTROL

⏚ - CHASSIS

⏚ - PANEL & CASE

* * FACTORY SELECTED VALUE

BOONTON ELECTRONICS CORPORATION

Model: 56A

Drawing No. 830019P

Warranty

Boonton Electronics Corporation warrants its products to the original Purchaser to be free from defects in material and workmanship and to operate within applicable specifications for a period of one year from date of shipment, provided they are used under normal operating conditions. This warranty does not apply to vacuum tubes that have given normal service, to sealed assemblies which have been opened, or to any item which has been repaired or altered without our authorization.

We will repair or, at our option, replace at no charge any of our products which are found to be defective under the terms of this warranty.

SHIPPING INSTRUCTIONS

If it becomes necessary to ship the instrument, the following steps should be followed:

a. **Wrap the instrument with heavy wrapping paper and seal the seams with gummed tape. Place in fibreboard carton large enough to permit three inches of soft packing material between instrument and sides of box.**

b. **Alternatively Boonton Electronics will provide an appropriate shipping container and packing materials at nominal cost. These may be obtained by writing to the Sales Department, Boonton Electronics Corporation, Route 287 at Smith Rd., Parsippany, N. J. 07054.**